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This serial report contains press and radio coverage on the development of and progress in the various theoretical and applied scientific disciplines and technical fields; and the administration, structure, personnel, and research plans of leading East European scientific organizations and institutions, particularly the academies of sciences.

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CONTENTS (Continued)

DEVELOPMENT IN ELECTRONICS IN COOPERATION WITH CEMA

Sofia ELEKTROPROMISHLENOST I PRIBOROSTROENE in Bulgarian No 3, 1979 pp 82-85

[Article by Engr Serafim P. Popov, director of Cooperation with the Socialist Countries Under the Ministry of Electronics and Electrical Engineering: "The Development of Electronics and Electrical Engineering in Bulgaria--The Result of Integration with the CEMA Member Countries"]

[Text] The most dynamic alliance, CEMA, this year celebrates its 30th jubilee. The 30-year history of the development of economic ties within the family of socialist states is affirmation of socialist internationalism and of the idea of a new type of the international division of labor, an example of interaction between fraternal peoples. The workers are profoundly interested in this permanent interaction for the sake of the common goal of the triumph of communist ideas.

It can definitely be said that the Bulgarian electronics and electrical engineering industry has been organized and undergone intensive and stable development due to close cooperation with the CEMA member nations, and mainly with the USSR.

Due to our participation in the bilateral and multilateral collaboration with the USSR and the basic CEMA member countries, our electronics and electrical engineering industry each year introduces around 400-500 types of new or modernized products, and at the same time new promising integrated developments are being made.

The data indicate that in the 1971-1975 period, a growth of 263 percent was achieved in comparison with 1966-1970. Over the same period computer equipment realized an average annual growth of 53 percent, by which Bulgaria ranks in one of the leading places in the world in terms of the per capita exports of computer equipment.

During the period of 1976-1980, the production of articles for electronics and electrical engineering in Bulgaria is to grow by over 2-fold.

The coordinating of the current and long-range plans between the CEMA member nations provides an opportunity to define the main directions and development rates for Bulgarian electronics and electrical engineering over the next 10-15 years. International division of labor on a bilateral and multilateral basis provides the necessary prerequisites for organizing large-series and efficient production of specialized products.

As a result of cooperation, during the period of 1976-1980, our nation has signed 87 agreements and treaties on production specialization and cooperation [subcontracting], including 57 agreements and treaties on a bilateral basis and 30 multilateral agreements and treaties concerning specialization within CEMA and international organizations. Up to now under bilateral cooperation 15 agreements have been signed with the USSR, 15 treaties with the GDR, 16 with Poland, 5 with Hungary, 4 with the CSSR and 2 agreements with Romania. On the basis of these agreements and treaties in 1978, our nation exported specialized products which represented about 52 percent of the total volume of realized exports.

Our nation takes an active part in all the diverse activities of the Permanent CEMA Commission for the Radio Engineering and Electronics Industry, the Intergovernmental Commission on Computer Equipment and the International Organizations of Interelektro [International Electronics], Interatominstrument [International Atomic Instrument], Interatomenergy [International Atomic Energy], and others.

The participation of Bulgaria in the activities of the permanent CEMA commissions and the international organizations is aimed primarily at accelerating integration processes in the area of production specialization and cooperation, scientific-technical cooperation, and standardization.

Within the Permanent CEMA Commission on Radio Engineering and Electronics Industry during the period from 1965 until the preparation of the first production specialization treaties, Bulgaria was a specialized nation for around 100 types of products of the radio engineering and electronics industry on the basis of the recommendations approved by the commission for production specialization and cooperation. The accepted recommendations helped to increase commodity turnover of radio engineering and electronics products with the CEMA member nations, but due to their nature they were unable to cause an efficient international division of labor in this area.

After 1975, when the first specialization treaties were worked out, Bulgaria participated in the treaties signed within the commission for multilateral international production specialization and cooperation of semiconductor instruments and integrated circuits, radio parts and components, radio electronic meters, special metering and testing devices for communications equipment, studio television equipment, and in group specialization for the production of semiconductor instruments and integrated circuits, special production equipment, special telephones, electronic-tube instruments, and so forth.

Scientific institutes in Bulgaria are involved in scientific research and experimental design work under 9 of the multilateral treaties signed under the commission for scientific-technical cooperation, and in the development of 115 plans for CEMA standards.

In giving enormous significance to the development of an overall concept and to the creation of modern data processing equipment in 1979 the governments of the six CEMA socialist countries, including Bulgaria, on a multilateral basis signed an agreement for the setting up of the Intergovernmental Commission on Cooperation in the Development, Production and Application of Electronic Computer Equipment.

Prior to the signing of the agreement, the socialist countries produced around 30 types of different incompatible electronic computers. The difficulty of their operation was further increased by the presence of different terminals. The technical and program incompatibility impeded the development of applied programs and this made the systems little productive.

With the approval of the Comprehensive Program for socialist economic integration of the CEMA member nations at the 25th CEMA Session in 1971, the necessary prerequisites were created for broadening and deepening cooperation in the area of electronic computers.

On the basis of the unified technical specifications and by the joint efforts of the socialist countries, the Unified System of Electronic Computer Equipment (ES EIT) was created, and this has technical, informational and program compatibility. Thus one of the most vivid examples of socialist economic integration was born and implemented in action. On the basis of the international division of labor, our nation takes a most active part in the development and production of products in the Unified System. Our nation is developing and introducing into production a central processor and 19 terminal devices. The ES 5012 external magnetic disc memory was the first device of the Unified System developed in Bulgaria, and this has succe-sfully undergone international testing and was put into regular production at the end of 1971. The ES 2020 central processor and the ES 1020 system developed on its basis were developed jointly with the USSR and put into regular production.

At present the USSR Ministry of Electronics Industry is developing the Elektronika 100-25 system, in using terminal equipment produced in Bulgaria. In the future our central processors will also be used in this system.

Miniterminals for use in the systems of small computers (SM-1--SM-4) are being developed with the USSR Ministry of Instrument Building, control systems and automation.

With the Cybernetics Institute under the Ukrainian Academy of Sciences in Kiev, we are developing problem-oriented computer systems which will be employed in the agriculture of the two countries.

In our cooperation with the USSR in the area of computer equipment, we must note the successful joint work of the collectives of specialists from the Moscow NII TsEVT [?Scientific Research Institute for Central Electronic Computer Equipment], the Minsk VNIIEVT [?All-Union Scientific Research Institute for Electronic Computer Equipment], and our Institute for Computer Equipment in Sofia.

The Robotron Association in the GDR is developing minicomputer systems using our peripheral external memory devices (minidisc and minitape). Our terminal devices are to be used in the GDR-produced systems of computers of the ES 1040 type and in the ES 1055 system which is being developed.

In cooperation with the Mera Association of Poland, the ES 8371 communications processor is being developed; the IZOT 310 minicomputer systems which are produced in Bulgaria are supplied with printers produced in Poland.

Cooperation with Hungary in the area of electronic computers is expressed in the development of cyclical domains together with the Hungarian Academy of Sciences; in addition the ESTEL teleprocessing systems which are produced in Bulgaria are to be supplied with the videoterminals produced at the Vieoton and Orion plants.

Together with the CSSR, we are developing data preparation systems using the ES 91 1001 flexible magnetic disc, on the VZUL 5004, and on a multiboard data preparation system; our external magnetic disc memories 100/200 MgB are to be incorporated in the ES 1025 system to be produced in the CSSR.

In a short period of time 12 new enterprises were built in our nation, and these are closely specialized in the production of electronic computer equipment for covering our needs and the needs of the nations in the socialist system for certain types of articles and computer equipment. The necessary development and personnel potential has also been created for the development and production of computer equipment. The basic directions in which electronic computer equipment will develop in Bulgaria are the following:

1) Electronic computers (central processors, controllers and minicomputers);

2) Peripheral equipment;

3) Teleprocessing systems and equipment;

4) Electronic calculators;

5) Technological [production] systems and equipment.

As a result of economic and scientific-technical cooperation with the socialist countries, our exports of electronic computer equipment to the USSR and the remaining socialist nations in 1975 rose by about 5.8-fold in comparison with 1971.

During the Seventh Five-Year Plan, the exports of electronic computer equipment, in comparison with the 1971-1975 period, will increase by more than 2-fold, and the share of exports of external memories represents 67 percent of the total computer equipment exports. This corresponds to the agreement prepared on a multilateral basis for production specialization and cooperation in this area.

In Interelektro, the international organization for the cooperation of the CEMA member nations in the area of the electrical engineering industry, 10 agreements have been signed on production specialization and cooperation, and Bulgaria is involved in them as a specializing country. Our nation participates also in 15 agreements to implement integrated programs for the creation and production of unified, standardized series of electrical engineering products. This will provide an opportunity to significantly renew these products.

In the international economic association Interatominstrument, our activities are aimed at production specialization and cooperation for nuclear equipment, at developing the direct economic activities of the association, at supplying the countries with nuclear physics equipment, including atomic power plants, and at the development of scientific and technical cooperation in this area.

Our involvement in the international organization Interelektrotest [?International Electrical Testing Equipment] will provide an opportunity to test our articles in high voltage and large capacity laboratories of the other CEMA member nations.

The development of Bulgarian electronics and electrical engineering is closely tied to the continuously broadening bilateral collaboration with the USSR and the other socialist countries.

At present the Ministry of Electronics and Electrical Engineering is cooperating directly with six Soviet ministries which produce electronic and electrical engineering products, as well as with ten other Soviet ministries which consume electronics and electrical engineering products.

Production specialization and cooperation are developing rapidly in carrying out the instructions of the party and state bodies and the Comprehensive Program for the Development of Integration. Eleven agreements have been signed for production specialization and the delivery of specialized products. These include 79 groups of products which determine the trade structure between the two countries in the area of electronics and electrical engineering. According to these agreements, Bulgaria is to be specialized in producing and delivering to the USSR, in addition to central processors and external magnetic tape memories and magnetic discs, automatic telephone exchanges, radio engineering communications equipment and agricultural control equipment, telephone sets, complete transformer substations, electrical tools, electric motors, electrical automotive equipment,

electronic monitoring and control equipment for agricultural machines, and so forth. During the Seventh Five-Year Plan, virtually one out of every two vehicles produced by the Volga Automobile Plant will be equipped with a Bulgarian generator, starter, ignition coil and generator-current and voltage regulator.

Bulgaria is to cover its basic needs for electronic and electrical engineering equipment by deliveries of special products from the USSR including electronic computers, radio and TV transmitters, studio equipment for color and black-and-white television, aircraft radar equipment, automatic control systems, ship radio equipment, electric power equipment, a broad range of electronic elements and integrated circuits, radio metering equipment, and so forth.

Joint work is also to be successfully developed in the area of developing new products. Agreements have been concluded on joint work in developing radio equipment for communications and the management of agriculture, and for the joint development of series of integrated circuits with a high degree of integration.

Work is also being done on developing systems for machine programming and the control of metering complexes for large integrated circuits.

The activities of the Soviet-Bulgarian Elektroinstrument [Electric Tool] Scientific Production Association is developing successfully in creating progressive designs for electric tools for further specialization and cooperation between the Bulgarian and Soviet enterprises within the association.

The agreement concluded in 1976 for setting up a Bulgarian-Soviet Interprograma [International Program] Institute with an affiliate in Bulgaria has created conditions for solving questions in the area of cooperation in the development of applied program packages for automated control systems.

Bulgarian electronics and electrical engineering is also involved in the building of projects on Soviet territory such as the gas line between Orenburg and the western frontier of the USSR, the Vinnitsa--Albertirsa electric transmission line, the Ust'-Ilimsk pulp combine, the Center for the Training of Flight Personnel, in creating capacity for oil production, and so forth.

Bilateral cooperation between Bulgaria and the GDR is also broadening and deepening. In the 1976-1980 period, deliveries of electronic and electrical engineering products between the two countries will rise by over 1.5-fold in comparison with the reciprocal deliveries carried out in the 1971-1975 period, and will reach around 26-30 percent of the total trade turnover.

The basic share of Bulgarian exports to the GDR is comprised of equipment for electronic computers such as the magnetic tape and magnetic disc memories,

office equipment such as electronic calculators, portable typewriters, high and low voltage equipment, the Crosspoint institutional automatic exchanges, structural elements, current sources, electric and pneumatic servomechanisms, thermoregulators, manometers, household appliances, and so forth, while GDR exports to Bulgaria will include high voltage equipment and transformers, welding equipment, bookkeeping and automatic office equipment, electrical and mechanical typewriters, billing machines, computer equipment, monitoring and metering devices, scientific equipment, medical and laboratory equipment, and so forth.

Ties and cooperation will be successfully developed between Bulgaria and Poland in the area of electronics and electrical engineering.

According to the long-term trade agreement between Poland and Bulgaria, during the Seventh Five-Year Plan, trade in the area of electronics and electrical engineering will rise by about 2.5-fold in comparison with 1971-1975. According to the previously signed bilateral treaties on specialization, in Bulgarian exports specialized products will comprise around 30 percent. As a result of the intensive work between the two countries in preparing and signing the new treaties on production specialization and cooperation, it is expected that by 1980 the share of specialized product in the total trade between Poland and Bulgaria in the area of electronics and electrical engineering is to reach around 40 percent. There is the positive phenomenon that progressive and rapidly developing product groups comprise the basic place in the trade structure.

Specialization and cooperation in electronics and the electrical engineering industry are being continuously developed and improved between our country and the CSSR, Hungary and Romania.

During the Seventh Five-Year Plan, the exports of Bulgarian electronics and electrical engineering products to the other CEMA member nations will increase by over 2-fold in comparison with the exports realized in 1971-1975.

The achieved results and the planned real prospects for the dynamic and efficient development of Bulgarian electronics and electrical engineering are inseparably linked to the ever broader development of socialist economic integration, and to the further merging of the Bulgarian economy with the economies of the fraternal socialist countries.

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PROGRESS, FUTURE TASKS IN ELECTRONICS RESEARCH

Sofia VECHERNI NOVINI in Bulgarian 8 Sep 79 p 6

[Article by Nadya Ilieva: "'Tapped' Electrons"]

[Text] Conversation with the director of the institute of electronics at the Bulgarian Academy of Sciences. The road to electronic systems starts at the scientific laboratories.

Electronic programming and planning of the production process, machines with electronic control, electronic testers, and outer space communications.... The installation of electronic facilities in the national economy and at home will become ever more tangible for all of us. Electronic equipment is a synonym of effectiveness, speed, and convenience. Its path starts at the scientific laboratories. They develop the basic problems of electronics and new directions, and resolve strategic problems of scientific and technical progress. This was the purpose of our meeting, on the eve of the September 9 holiday, with Doctor of Physical Sciences Aleksandur Spasov, senior scientific associate first class, director of the Institute of Electronics of the Bulgarian Academy of Sciences:

[Question] Comrade Spasov, we shall discuss the latest successes of your collective. Yet, let us also recall the beginning, the first steps.

[Answer] The institute was created 15 years ago in order to provide a scientific base for the development of electronics in our country. It was here that the foundation of a number of modern strategic directions in Bulgarian radio physics and electronics were laid. Thus, for example, the initial successes in the field of quantum electronics and laser technology were achieved by our associates. The first Bulgarian laser was developed only three-four years following the discovery of the basic laws governing quantum electronics in the world and that the USSR and the United States built the first lasers.

[Question] Today throughout the world quantum electronics is developing quite tempestuously. What type of lasers are you developing currently in the institute?

[Answer] We are working mainly on gas and solid state lasers, colored lasers, and laser systems. They have a promising use in science, industry, and medicine. You are aware of the great practical effect of laser atmospheric sounding. Together with colleagues from the Siberian Department of the USSR Academy of Sciences we are developing the theory and creating one-of-a-kind equipment fast long-range studies of atmospheric parameters and pollution, the detection of hail-bearing clouds. etc. Several expeditions were conducted jointly with specialists from the Tomsk Center, Siberian Department, in the course of which the new equipment was tested.

[Question] Electronics is closely linked with the concept of information, and information transmittal. The question of expanding the possibilities of data transmission systems has always been topical. Today the volume of such information is growing with every passing second. How will modern electronics resolve this problem and what studies are being made by your collective in this direction?

[Answer] These problems involve super high frequency radio physics and electronics. New communications systems must be developed, using satellites. We have achieved considerable successes in the study of anisotropic wave conducting structures with controlled characteristics. We are developing generators of super high frequency oscillations with modern semiconductor elements, and quiet parametric boosters used in radar, radio relay systems, and space communications systems. The economic effect of the application of a single one of our developments in this field in 1978 amounted to 630,000 foreign exchange leva.

Studies related to the creation of fibrous-optical data transmittal systems are very interesting and promising. The institute has developed two lines for the transmittal of analog data (telephone communications and television programs, for example) with Bulgarian optical electronic elements. On this matter we are working together with the USSR Academy of Sciences Physics Institute and the Scientific Research Institute of Communications of the USSR Ministry of Communications.

[Question] We are discussing the new directions. Of late kryogenic radio physics and electronics has stirred up a lot of noise.

[Answer] We have been working on the problem for only a few years. However, we have already developed a superconductive magnetometer of exceptionally high sensitivity. Such systems will be applied in scientific experimentation, biology, medicine, and geophysics.

Other new studies involve high temperature plasma, applied in magnetohydrodynamic energetics and plasmochemical technology used in processing substances and applying melting-proof linings.

[Question] You have named a number of interesting developments. However, could you indicate the top achievements of the institute at present?

[Answer] It would be hard to answer this question. We are working in the front line of science and we try to be on the level of world-wide achievements. I would consider as significant successes achieved by the institute the system of laser sounding, the superconductive magnetometer, lasers, and systems for fiber-optic communications. We recently completed and you will be able to see in the laboratory a system for electronic printing--one of the most promising technologies in the field of contemporary microelectronics. A number of systems were developed for obtaining super high vacuum....

...Tomorrow here, in the laboratories with complex electronic equipment, there will be silence. The physicians and engineers of the institute will celebrate the anniversary of the day which opened the way to our socialist science. Many of them have the age of our freedom.

5003
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MSD-1300 TRANSLATING MACHINE CAPABILITIES DESCRIBED

Sofia VECHERNI NOVINI in Bulgarian 8 Sep 79 p 6

[Article by Nadezhda Chakurova: "The MSD-1300--An Original Bulgarian Invention Which Provides A Shorthand Record, Deciphers, Translates and, Along With the Linguistic Information, Provides a Print-out"]

[Text] Such a thing had never happened to us before. The tape recorder we carried would not be asked to record. Nor would we need paper and pen. A machine will replace all of them. It will record everything and the ready text would come out of its printing system. Operator Lyubka Dimitrova took her position in front of the panel--it was a somewhat strangely looking kind of typewriter which contained, instead of a block of letters, three block of blank keys. Actually, we came here at the Cybernetics of the Shorthand Process Laboratory at the State Stenographic Institute, to study this unique system.

For some 20 years professional shorthand writing has been in a state of crisis. It has been purely and simply fading away. Ever more frequently, whenever a record is needed, the tape recorder has been used. Subsequently, the recording may be transcribed by a skilled typist. What to do? This question drew the attention of scientists throughout the world. The laboratory collective spent nearly four years to study the reasons for this condition in stenography and to find a solution. It also studied the economic justification of the three-year training course after which only a few of the some 200 graduates of the shorthand and typing school in Sofia find jobs as stenographers.

The small enthusiastic collective of the laboratory combines the rich practical experience of the best stenographers and the daring of the young. It followed a entirely new way in seeking a rational solution to the problem, different from the one followed in the United States, France, and Japan. A shorthand system was developed, using symbols borrowed from ancient pictograms and ideograms. The system simplifies both the training and work of the stenographer. It can be mastered by a student in only three months. At that point, the specialists asked themselves the following: What would happen if

the new system were to be used with a machine? Computations and designs were initiated, with one sleepless night after another. Finally, a new item was born. The operator at its panel combines the skills of a stenographer, typist and...translator. Regular text comes out of the printing system of the MSD-1300, together with linguist information. Again, no more than three months are needed to master the use of this machine. Labor productivity in tranining has been raised tenfold!

"What is typical of our machine," said Nevena Atanasova, operators' training instructor, "is the conversion from the single-letter alphabet system to a multiple letter system in which a single strike (on a key) will record a syllable of two, three, or four letters. The period following the ultimate syllable also notes the interval between letters. The symbol for period engages the capital letter. The writing system automatically shifts to a new line. The machine could translate into 11 languages. A single key on the panel can change the script to the Cyrillic or the Latin alphabet....

The new machine has a number of other advantages. However, let us make the following comparison alone: With a standard typewriter a 30 line page has 300 interval strokes. the MSD-1300 eliminates them, thus providing 15 additional lines--one-half of a standard size page. The conventional typist types 2000 strokes per page while the machine shorthand typist types only 500. It is incredible but a fact, as the saying goes. And, since we mention facts, let us indicate two of them:

At the end of July 1979 the 33rd Congress of the International Federation of Shorthand and Typing, INTERSTENO, was held in Belgrade. For the first time in the history of the federation two new competitions were organized: in machine stenography and stenography in several languages. The MSD-1300 was rated among the best.

Last August an international symposium on the Banner of Peace Assembly--The Child, the Creative Beginning, and Evolution--was held in Sofia. There were three topics. There were two-day discussions on each. On the third day a neatly bound copy of the entire minutes was given to each of the delegates, in their own language. One of the guests at the symposium, the famous Soviet Cybernetist N. A. Amosov, said: "I have attended a number of symposiums, congresses, and conferences. However, I have never seen such a high level and speed of processing of minutes and diaries. This is an amazing accomplishment. As a cybernetist dealing in particular with artificial brains I am amazed at your machine and your accomplishment."

The MSD-1300 has been already patented in 20 countries, including the most developed ones. Requests for information has been received by the IZOTIMPEKS foreign trade center from parliamentarians, company directors, and heads of schools and scientific institutions. The Optikoelektron plant in Panagurishte will try to meet all requests while we, the guests of the Cybernetics of the Stenographic Process Laboratory, were given by our kind hosts a ready transcript of our conversation.

From the machine the text goes directly to the editor's desk....

The MSD-1300 means typing, stenography, and transcription. Everyone can guess the meaning of the 1300--dedicated to the 1300th anniversary of the Bulgarian state, it is also a wonderful gift in honor of the 35th anniversary of our socialist revolution.

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EFFECTIVE USE OF ROCKETS TO DISSIPATE HEAVY STORM CLOUDS

Sofia ANTENI in Bulgarian 15 Aug 79 p 5

[Article by Nikolay Zhekov: "'Come Back Faithless Cloud!' Rocket War Against Hail"]

[Text] In order to avoid long literary metaphors, the picture following the hail storm which struck 14 July last the area of Byala Slatina resembled the one described in Yavorov's remarkable poem. The corn, vegetables, wheat, tobacco, and other crops were leveled off with the ground. The ducks, harbingers of the misfortune, were not only shrieking as in Yavorov's poem, but about 5,000 of them, which happened to be in the area of the Skut River were killed by the icicles. A number of trees fell and many houses remained without a single unbroken tile or glass panel. Some of the hail lumps weighed as much as 700 grams. The crops of Komarevo Village were totally destroyed. Other casualties were the villages of Borova, Nivyanin, Vranyak, Tlachene, Sukhache, Lepitsa, etc.

However, one substantial difference separates this event from the one described by the brilliant poet.

Some 10 years ago curious reports were published in the press to the effect that clouds could be "broken up" with shots. Many people may be unaware of the fact that for the past few years we have had an entire equipped "army" to strike at dangerous clouds. Rocket pads have been built in traditionally most hail prone areas in Plovdiv, Sliven, Vidin, Mikhaylovgrad, and Vratsa okrugs. A launching pad is under construction at Dolni Dubnik in Pleven Okrug.

Soon after the hail storm I visited the anti-hail launching pad not far from Byala Slatina. Following is a summary of my conversation with specialists on the 14 July events:

"At 1507 hours the first hail-bearing cloud was detected by the radar. It was followed by several other which presented no difficulty. The second and

far stronger stage began at 1600 hours. Two strong cloud zones developed, merging not far from the launching pad. Our rockets yielded excellent results. The crops were hit by a softened hail mass and damages were insignificant. The third powerful invasion stage developed at 1745 hours. We hit the broad cloud zones from all rocket launching pads. We successfully repelled the attack without casualties. However, our rocket supply was exhausted. A new powerful zone developed at 1810 hours. This time, however, all we could do was observe. Seven minutes after seizing the fire a terrible hail poured down. Heavy damages were inflicted. The final, fifth stage was deployed at 1922 hours. We realized how badly one feels being defeated only by the lack of ammunition."

Probably it is the result of the active solar year making this season unique in terms of hail activities. Last year 1807 rockets proved to be sufficient for all rocket launching pads of the firing ground. This year, however, more rockets were available and 3,200 of them were fired through the evening of 14 July. Nevertheless, they proved to be insufficient....

The firing ground commands 18 rocket launching pads evenly deployed on the defended territory totaling 1,263,000 decares. It has a radar station (and an emergency radar station) for constant sky watch. Should a target appear on the screen bearing the respective alarming characteristics, they are reported to the command center. The official on duty at the center follows the movement of the clouds and, if necessary, orders by radio the rocket launching pads to "stand by" and "fire," giving them the coordinates. The rockets do not totally destroy the cloud through direct hits but make it harmless. The rocket, over one meter long, carries a reagent--silver or lead iodide, with pyrotechnical components, weighing one kilogram. Science is not entirely clear as to what develops within the cloud. We know, however, that the water drops freeze more easily around small particles--dust specks. In a cubic meter of cloud mass up to 50 bits of hail form naturally. If their number is lesser they become bigger and more dangerous. The purpose is to increase their number to a maximum extent through the artificial introduction of dust particles in the cloud. This is the job of the rocket when it explodes and spreads the reagent. At that point a harmless snow mush falls on the ground instead of hail....

However, clouds may be defeated for months on end. Thousands of rockets may be fired, yet everything may turn out to be meaningless if there is a shortage of ammunition in fighting the final battle.

The Agrochemical Services DSO [State Economic Trust] in Sofia has a Hail Prevention Administration. We spoke with its chief, Ivan Kuchev. Yes, there had been a solution and the sky alone was not to be blamed. It became clear as early as May that the year would be exceptionally hail-active. In the course of the month the number of rockets fired was higher by a 3.6 factor compared with May of 1978.

On 31 May Ivan Kuchev sent his first report to the National Agroindustrial Union on the urgentcy to import rockets. The second was sent on 3 July and the third after the hail struck.

This is as far as my "studies" have taken me on the reason for the unavailability of rockets in the decisive hours of 14 July. This is not what I wanted. I was more interested in finding out what is the effectiveness of the national hail prevention service. Currently our rocket launching pads are protecting from hail 15 million decares of land. Last year the cost of protecting from hail one decare was 1.17 leva. Yet, could we estimate how many leva it saved per decare by protecting it from the hail? It would be hardly possible to develop a method for precise computations. However, unquestionably, the usefulness of the work of the hail protection service is unquestionable. Whereas prior to its establishment we had approximately 100 decares of land hit by hail, today the number has dropped to 40. In other words, there will be hail in the future as well but to a far lesser extent. By improving the equipment and the organization of the work, and resolving the cadre problem, the percentage of success could rise from 60 to 80, as is the case in Soviet Georgia which is assisting us in such useful activities.

Our universities offer no training in anti-hail activities. For the time being we use physicists whose skills come the closest to the requirements. We do not know why young people are not sent to train at the Odessa or Leningrad geophysical institute.

The use of rocket launching pads in fighting hail storms is so unquestionable that last July the Council of Ministers approved the decision to set up a national hail prevention system. In the course of its two stages, through 1986, its program stipulates the building of yet another 27 launching pads which, together with the already existing ones, will protect 85 percent of arable land.

Despite partial victories over hail storms, an ever larger number of rockets will be fighting them. Today we can no longer be satisfied with the incantation of "Turn back faithless cloud." We must bear in mind the three words inscribed on the asphalt of the Byala Slatina firing grounds "Remember--never hail!"

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ELECTRONIC TECHNOLOGY RESEARCH AT BUDAPEST TECHNICAL UNIVERSITY

Budapest FINOMMECHANIKA-MIKROTECHNIKA in Hungarian No 8, Aug 79 pp 225-226

[Article by university professor Dr Andras Ambrozy, BME's (Budapest Technical University) Department of Electronic Technology: "Research Activity of BME's Department of Electronic Technology"]

[Text] The article summarizes the research activity of Budapest Technical University's Department of Electronic Technology. It lists the four main research directions pursued at the department and also shows the relationship between these. In this issue of the magazine additional articles provide detailed analysis of the specifics of solving each of the individual problems.

The Department of Electronic Technology was established in 1964, thus it is now exactly 15 years old. This decade and a half coincided with tremendous advancements in electronic technology. While in the early 1960s the classic machinery industrial, metal working technologies still dominated even the electronics industry (1), today the physical (for example vaporization, atomization, diffusion, treatment with laser beams) and chemical (for example the electrochemical) technologies demand increasing shares for themselves. In the meanwhile there are increasing demands for precision mechanics instead of simple metal working.

Development histories of the various universities vary, thus the expression "electronic technology" also covers varying contents. In the Anglosaxon countries for example it is used in a much broader sense than in Central Europe. In the latter geographic area perhaps the following definition is correct: electronic technology is the science and art of the realization of electronic parts, circuits, apparatus and equipment.

Naturally the university's traditions also influence the structure of the departments. There are no two universities where exactly the same organizations developed, since the industrial structures of the respective individual countries also differ.

The research and educational activities of the BME's Department of Electronic Technology can be listed in four groups:

1. Physics technologies
2. Electrochemical technologies
3. Precision mechanics
4. Technological equipment and their control.

The department works on those basic technologies which are needed by the industry. It solves not only laboratory problems but also ones of pilotplant magnitude and even ones of the order of magnitude of production plants.

In the following we will emphasize a few of the tasks which are being worked on in this four-way grouping:

The physics technologies are oriented strongly towards microelectronics: we prepare and examine thin and thick layer structures. Among our experiments and examination methods the following deserve attention:

--Preparation of thin layers with prescribed lateral inhomogenity.
--Preparation of hard, heat resistant thin layers.
--Electrical, optical and other studies on thin layers (for example failure analysis with collateral noise measurement).
--Comparative studies between electroerosion, laser and erosive beam value calibrations.
--Laser cutting of silicone sheets.
--Mechanical tensions generated in the carriers of hybrid microelectronics during manufacturing.
--Reliability studies of microelectronics components.
--Topological planning of thick layers (assisted by computer).

Currently the main topic of the electrochemical--and in part also of the chemical--technologies is printed circuitry, or the coating of contactors with noble metal. Advanced development of metallized-core printed circuitry in the direction of very fine designs and multilayered structures is an everyday activity for us. All these require a large number of experimental pieces; these at the same time also satisfy the development needs of other departments of the University or of some enterprises. Besides making improvements on the technologies, usually we also offer comments on the individual constructions, make suggestions for refining the planning of machinery, etc.

Among the investigative methods of the technologies listed above, the following deserve to be mentioned:

--Evaluation of materials received.
--Measuring the precision and shape retentivity of large-sized master drawings and master films.
--Comparison of phototechnolgies.

--Electrical evaluations.
--Reject and reliability studies.
--Atomic absorption mass-spectoscopy to discover trace elements and impurities.

In recent years an interesting and useful cooperation has developed between the department and the University of Karlsruhe. At the latter place a small group is working under the leadership of Professor Feiertag: their specialty is the measurement of very small changes in shape by laser interferometry, and the equipment available to them for this purpose is very good. The purpose of our cooperation is to locate such weak points on the drawings and/or in the technologies which can cause catastrophic failures in printed circuits operating under harsh circumstances (in vehicles, household appliances).

Precision mechanics can be of great assistance to both the microelectronic as well as to the electrochemical technologies with small size and high precision manufacturing tools and movement mechanisms. Of this group's development activities the following deserve attention:

--High precision x-y coordinate table for microelectronic technologies.
--Precision tools, clamps, contactors for adjusting the values of thin layer resistances.
--Study of the nature of friction; designing friction-free moving parts.

Finally the fourth direction must also be mentioned. The processes of electronic technology--if they can be reduced to writing in an exact manner--are complicated functions, with several variables, of technological parameters which [paramaters] can generally be treated as probability variables. Therefore the gathering and processing of measurement data is indispensible. Large computers are not necessary for this, and in the shop environment they aren't even always able to function. We have therefore directed our attention to employing microprocessors in electronic technology. Some of the more interesting examples are:

--Translation of higher level languages which describe drawings for the purpose of controlling drafting machines which can be operated in steps.
--Application of microprocessors for checking the correctness of drawings, for generating simple transformations (projections) and repetitive shapes (for example weld beads), and for working out optimal drilling strategies.

The above examples are based on simple Euclidean geometry. In order to describe complex technological processes first of all an appropriate model has to be developed. In this respect we can mention the following things:

--Model of the vacuum vaporization process for the purpose of producing layers with greater homogenity, or even with prescribed inhomogenity.
--Modeling the heat distribution of a thermal printer which can be built with continuous resistance strip.

The activities of the four groups mentioned above are not separated artificially from each other at all. I would like to mention only two examples; these precisely characterize the intertwining of the work of the groups.

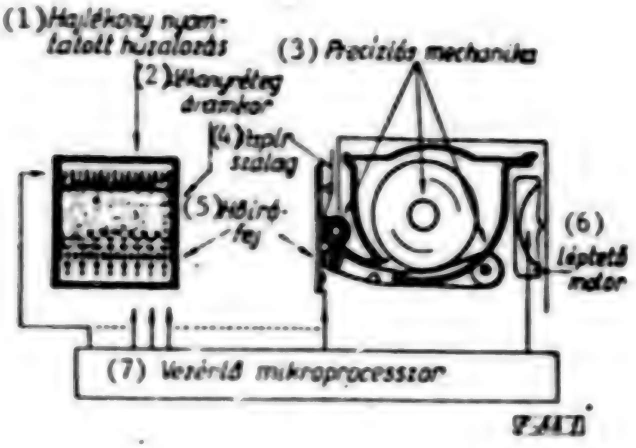

Figure 1. Schematic drawing of the thermal printer and of the elements connected to it.

Key:

1. Flexible printed circuitry.
2. Thin layer circuit.
3. Precision mechanics.
4. Paper strip.
5. Heat-writing head.
6. Step [stepping] motor [drive].
7. Controlling microprocessor.

Figure 1 shows the schematics of a complete thermal printer. The hard and heat resistant thin layer needed for thermal printing was worked out by the microelectronics group. They found several viable solutions. The complete measuring head also contains flexible printed wiring--this is the work of the electrochemical group. The strip relay mechanism was designed by the precision mechanics, and the final studies were done with microprocessor control. The capabilities of the microprocessor can naturally be well used in the final production, for example for character generation, controlling the printing points in the appropriate sequence, etc.

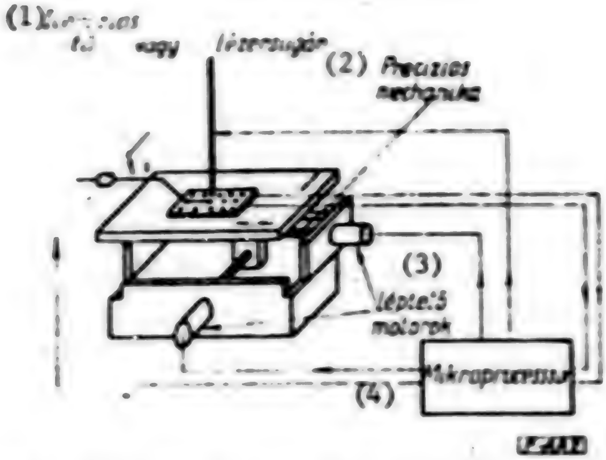

Figure 2. Schematic drawing of the microelectronic coordinate table and of the elements connected to it.

Key:

1. Beam-erosion needle or laser beam.
2. Precision mechanics.
3. Step [stepping] motors [drives].
4. Microprocessor.]

Figure 2 shows the universal microelectroelectronic x-y coordinate table. Its maximum travel is 50 mm in each direction, its precision is ± ? to 10 mm. This complicated precision mechanical structure is operated by NC control; an earlier design was built with the traditional integrated circuits, but the variation which is now being developed is naturally based on the microprocessor. The x-y table is equally useful for laser and electroerosion work on thin and thick layer resistances and circuits.

The multifaceted activity listed above may appear to be too great for a department in which about 30 degreed people work. However, as background, a--for the most part--very dedicated team is at work. A significant portion of their normal teaching activity is the "independent design" which extends over 3 semesters. Credit for some of the above described development results must be given to the cooperation of talented students. Besides this, in Hungary the BME's Electrical Engineering Department is the only [university] department where postgraduate training is available in the form of daytime studies. The students participating in this naturally receive bigger, more complex assignments besides their course work studies. These students work devotedly on their assignments not only during the strictly construed working hours but also for example during the weekends.

At the best this brief introduction can provide a superficial review about our research activity. In this issue of the magazine devoted to the topic, articles written by the department's coworkers provide deeper and more detailed insight into our activity.

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ULTRASONIC CHECKING OF PRIMARY-CIRCUIT MAIN EQUIPMENT

Budapest GEP in Hungarian Vol 31 No 7, Jul 79 pp 260-263

[Article by Gyorgy Tarnai, graduate mechanical engineer, welding specialist; and Agnes Mester (Mrs Vekas), Dr, graduate mechanical engineer "Ultrasonic Testing of Primary-Cycle Main Equipment at the Startup and Subsequent Retests"]

[Text] 1. Measures Aimed at the Safe Operation of Nuclear Power Plants

As the number and output of nuclear power plants increases, there is more and more radioactive material in use. This represents an increasing hazard to densely populated areas. As a result, there are more and more measures introduced in the major industrial countries leading the installation and operation of nuclear power plants (USSR, USA, FRG) aimed at ensuring safe operation.

In addition to developing methods of testing, it is also very important to develop many major checking conditions simultaneously:

- Quality standards;
- Test equipment;
- Establishment of the engineering conditions.

The quality standards must be developed (updated) as developments take place in the nuclear power plants. Changes in standards, specifications, and so forth create majo· problems for the designers, builders, supervisory authorities, and testers.

The testing setup is in the process of dynamic change in the countries where nuclear power plants are built or operated. It is important to realize that

designing, manufacturing, installing, and repairing activities must be closely coordinated via the establishment of the quality-assurance system. This system encompasses not only in-manufacture and acceptance testing but also testing during operation.

The testing conditions can be met only with a "test-facilitating" design set up with the intended quality-assurance system in mind, as well as with extensive "built-in" testing facilities (mostly of an automated character) designed for the equipment concerned. These facilities also include the testing personnel.

On the basis of experiences gained in the testing of nuclear power plants the test-engineering research has been speeded up. The examinations carried out demonstrated that safe operation is possible only if high-quality tests, supplying quantitative data in an automated manner, are carried out during first startup and subsequent retests. Of course, these tests, especially the first startup test, must be carried out after manufacture and installation are completed and checked out. It is evident that the first startup test ("0" state test) represents the base, the reference level, of the subsequent periodic retests.

2. Principles of the Test Schedule of Nuclear Power Plants

To ensure a safe environment, the reactor body and the connected pipe systems must be properly tested at first startup and during subsequent retests during operation.

When designing the test schedule, consideration must be given to the nature of the defects that may arise and their mechanism of development. One starting point is the exploration and recording of the minor continuity faults and the permitted inhomogeneities at the start (first startup test). Another reference point is the fact that only defects of the crack type are expected in the reactor body during operation. The orientation of some of the cracks can be forecast.

In designing an ultrasonic check test schedule, consideration must be given to the following factors:

- Scanning must be feasible from at least one side along the entire surface;
- The full wall thickness must be testable;
- The method used should, to the maximum possible extent, be orientable to the direction perpendicular to the crack-propagation direction.

- The method of testing should be suitable for cracks practically perpendicular to the surface, but also for the detection of joint defects parallel to the surface (this applies to both internal cracks and cracks which reach the surface);
- The method should provide a high degree of defect-detectability;
- The results of the test should be easy to interpret to permit qualtitative conclusions to be reached with respect to the formation and propagation of defects (cracks) discovered at the retests;
- The ultrasonic method of testing should be matched to the material involved (composition and wall thickness) and configuration.

The dependability of the testing depends on the coordination of the method of testing and the method of evaluation. Because of the special requirements and the high level of required performance the method of testing is based on the use of advanced ultrasonic techniques. This is a complex method of testing, involving complex mechanized movement, which can be implemented ony if it is paired with an automated method of evaluation.

3. Automated Ultrasonic Testing of Nuclear Power Plants at the First Startup and During Subsequent Retests

For all practical purposes, testing of the reactor body and the tube flanges must be carried out over the entire volume, with special defect-indicating facilities. This requirement plus the fact that accessibility is limited as a result of the radiation hazard necessitates the implementation of an automated testing system. Such a system is also desirable for economic reasons.

3.1. Block Diagram of the Automated Ultrasonic Test Setup.

Figure 1 shows those major parts of the ultrasonic test system which are functional parts of every automated ultrasonic test equipment. Insofar as its function is concerned, the system is modular. Its main parts, which are not necessarily separate units in spatial terms, are the following:

- Devices for the generation and transmission of ultrasound-frequency electric signals (ultrasound generator, amplifier, signal generator, ultrasonic monitor);
- Probe combination for generating and receiving the ultrasound;
- Stepping unit which—during continuous movement of the probe—performs the temporal coordination of the signal-transmission system;
- Couplers;
- Manipulator track gauges capable of providing information concerning the relative movement of the probe and the test object;

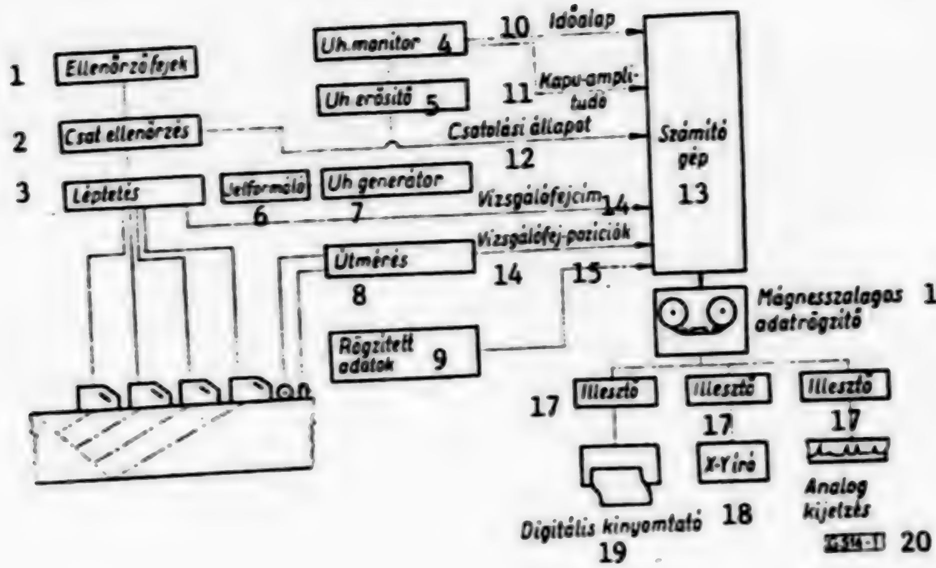

Fig. 1. Block diagram of the automated ultrasonic test

Key:

1 - Test probes	11 - Gate amplitude
2 - Coupling check	12 - Coupling state
3 - Stepping	13 - Computer
4 - Ultrasonic monitor	14 - Probe address
5 - Ultrasonic amplifier	15 - Probe positions
6 - Signal former	16 - Magnetic tape recorder
7 - Ultrasonic generator	17 - Coupler
8 - Track distance measurement	18 - X-Y recorder
9 - Fixed data	19 - Digital printer
10 - Time base	20 - Analog display

- Fixed data required for the testing and the subsequent evaluation;
- Automated evaluating system for the information provided by the above devices, meaning a computer capable of detecting the defect and of displaying a broad range of information concerning the conditions of the testing;
- Recording facility for storing the data;
- Result-displaying devices such as digital displays, X-Y printers, and analog displays.

3.2. Requirements Imposed on the Automated Testing System

The following are the general requirements for the testing system:

- The system must be capable of testing the reactor body and the tube flanges over the full surface and volume, in accordance with the provisions of the applicable specifications;
- The system must be capable of checking for cracks perpendicular to the major stress directions;
- The system must exhibit a high degree of dependability and reproducibility (good positioning);
- The system must be simple to calibrate;
- The manipulator must be adapted to the prevailing needs;
- The system must be highly automated.

For nuclear power plants we require a testing system which features the following:

- The system must have an ultrasonic metrological approach which gives unambiguous results for defect detection and characterization;
- The probes are mechanically manipulated and moved;
- The system has the remote-control feature, which may also be operated manually, according to a predetermined program;
- The data-processing equipment of the system must be capable of determining the movement of the probe, detecting the defect, and evaluating the result;
- The result-display unit must be suitable for documentation and storage.

3.3. Function of Some of the Major Parts of the Automated Ultrasonic Testing System

3.3.1. The Manipulators Which Move the Probes

The construction of the manipulators will depend on the type, surface, and configuration of the parts to be tested. Major factors which contribute to satisfactory operation are the following:

- A mechanical track capable of guiding the probes according to the configuration concerned;
- Universal holder capable of accommodating the various testing units and permitting them to be replaced;
- All movements of the probes must be mechanized and carried out at various speeds;

- Track distance measurement must be possible along all three coordinates;
- Measures must exist for orienting the manipulator with respect to the reactor body, and repositioning with a crane;
- The manipulator must be decontaminable after completion of the testing.

3.3.2. Remote Control of the Automated Testing System

The remote-control system encompasses the electronic devices performing functions related to defect examination and manipulation.

The following are the major requirements for the control:

- The control must enable the storage of sufficient information, meaning track and switching information;
- The control must ensure that the probe and the manipulator are protected from collision during malfunction or operating error;
- The control must provide constant switching and sensitivity checking during the test.

3.3.3. Evaluating and Data-Processing Units of the Testing System

The following are the main characteristics of the system:

- The cathode-ray tube's horizontal axis may be divided, individually evaluated, and displayed by using the so-called "multiple Gate";
- The test can be carried out simultaneously on several channels; the probe pairs are operated consecutively; the probe speeds are appropriately controlled;
- In general, the system has analog and digital outputs for each gate in addition to the conventional cathode-ray tube display;
- Means are provided for checking the coupling.

Evaluation takes place on the basis of the incoming data, as well as the data gathered during the first startup and the threshold values concerned. The computer classifies according to the program in three categories:

1. "No Change"
2. "New defect"
3. "Increased old defect."

4. Tasks of Preparation in Hungary

The foreign experiences referred to above and the summarization of the modern automated ultrasonic system requirements hopefully indicate the complexity of the testing procedure and the major difficulties. It takes

experience and knowledge not customary in Hungarian practice to adapt and implement a well-thought out testing scheme designed specifically for the testing of reactor bodies and tube flanges.

The preparation for this task is made more difficult by the fact that we do not know everything yet about the control system to be supplied for the nuclear power plant in Paks. However, we believe that we may domestically prepare ourselves; more precisely, that we must get ready for the acquisition of the testing system.

The basis of the preparation is a research project combining the efforts of several institutions. The tasks appear to be the following:

- Determination of the potentials and limitations of the testing of austenitic steels;
- Determination of the potentials and limitations of the testing of plated steels;
- Studies on the practical implementation of automated testing techniques;
- Analysis of methods suitable for the automatic recording and evaluation of the results of the automated testing.

We also recommend the selection and systematic training of personnel for carrying out the tests and for operating the testing sytem.The difficulties involved in establishing the personnel prerequisites needed should not be underestimated.

We must exert special effort to acquaint ourselves with the parameters and system characteristics of the testing equipment to be procured. In our opinion it is important to set up a consultation mechanism within the CEMA countries with the authorities concerned.

We must stress that it takes much time to acquire a high-quality testing system. Above we discussed only those subjects which appear to us to be the most important. However, in our opinion we must establish the ways for acquiring the ultrasonic method and the start of studies concerning practical implementation.

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AUTOMOTIVE DEFECTOSCOPY FOR TESTING PRIMARY CIRCUIT MAIN CONDUITS

Budapest GEP in Hungarian Vol 31 No 7, Jul 79 pp 258-260

[Article by Tamas Sipos, Geza Belhazi, Otto Lecz, and Zoltan Fekete, Isotope Institute, MTA (Hungarian Academy of Sciences), Budapest]

[Text] The authors describe the main construction and operation features of a mobile, remotely controlled defectoscope suitable for the visual examination of the interior surface of the main conduits of nuclear power plant blocks of Type VVER-440, as well as for the gamma-radiographic testing of the welded seams of the conduits.

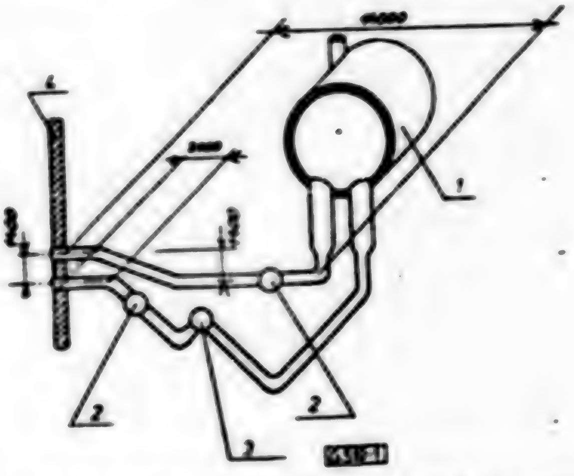
Safety is the main consideration when building a nuclear power plant. The nondestructive testing of the main loop must be carried out at first start-up and then later during the maintenance shutdown periods.

One Type VVER-440 reactor and six circulation loops are assigned to a nuclear steam-generating system of the nuclear power plant. The output of the steam generator is 1,375 MW. Maximum pressure of the heat-carrying primary-loop water is 12.7 MPa (125 kp$\cdot$cm^{-2}); its temperature is 568°K (295°C). This represents a severe mechanical and heat stress for the parts of the circulating loop. If, in addition, we take into consideration the fact that the circulating pumps create additional vibrations, we realize that the periodic check testing of the system is an important requirement.

The defectoscopic system, which we have developed in a study, is suitable for carrying out visual examination of the interior of the circulating loops and also for examining it by means of gamma radiography.

The layout of a circulating loop is illustrated in Fig. 1. It can be seen that the pipe system to be tested has horizontal, vertical and tilted

sections, joined by pipe arcs. The internal diameter of the pipes is 492 mm; the wall thickness is 34 mm. The minimum bend radius is 560 mm. The pipes are made of corrosion-resistant steel. The pipe sections are joined to each other and the other fittings by means of arc welding, using argon protective gas.



1. ábra. Keringtető hurok; 1. Gőzfejlesztő; 2. Tolózár; 3 Főkeringtető szivattyú; 4. Reaktortartály

Fig. 1. Circulating loop
Key: 1 - Steam generator
2 - Slide lock
3 - Main circulating pump
4 - Reactor vessel

In designing the defectoscopic system, we first sought a proper method for carrying out the tests.

Insofar as visual examination of the interior is concerned, defect recognizability is an essential requirement. We carried out tests with an industrial television system and with a photographic device. For the studies we mounted the camera on a suitable screen since this was the only way in which we could obtain evaluatable pictures because of the strong shine of the interior pipe surfaces.

For the photographic experiments we used a PRAKTIKA VLC camera, equipped with a FLEKTOGON 2.8/35 optical system. The film used was ORWO NP 15. The parameters of the best pictures obtained were the following:

Light gap: 16; exposure time: 1 sec. A 20 cm by 30 cm area may be photographed in one exposure. The minimum still recognizable defect width was

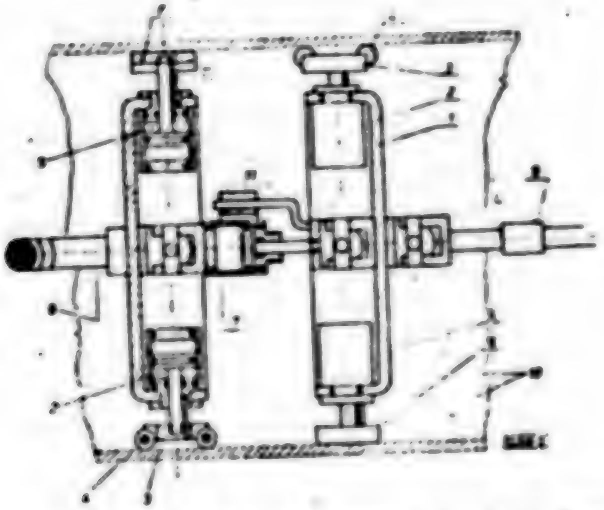
0.025 mm. Since the photography must be carried out in a strongly contaminated environment, we examined the radioactive dose tolerance of the film used. We found that the increased background blackening of the film does not interfere with the picture quality at dose rates of up to $7.74 \cdot 10^{4}$ $C.kg^{-1}$ (3 rd). According to our calculations, however, the actual exposure would be at most one-third of this. We also examined the use of a domestically made industrial television system. In the tests we used the domestically made MINILUX tv 11-23.0 camera, with an ITV 13-10 constant-angle camera optical system and an ITV-18-12/T monitor. The pipe-wall surface acquired at a time was 9 x 11 cm. We found that the limit or defect detectability was 0.025 mm in this case also. We also investigated the possible use of fiber optics. According to factory catalogs, only a 5 x 5 cm area could be examined. The diameter of the endoscope required for this would be 43 mm, while the maximum possible endoscope length no more than 24 m. Since these parameters are insufficient for our purposes, we rejected this method.

Based on all this, we recommend the industrial television system combined with a videotape recorder. We obtain a satisfactory series of pictures for comparison purposes by carrying out a first-startup test before the plant is first used, recording the pictures, and comparing them with the pictures recorded in subsequent retests.The two sets of pictures can be projected onto a monitor for this purpose, so as to permit detection of any changes in the internal pipe surface.

For the gamma-radiographic studies we adapted the exposure head of the mobile seam-testing gamma defectoscope developed at our institute and used with success over a period of several years. The source is Ir-192, 2 mm diameter by 2.4 mm active size and maximum activity of 3.7 TBq (100 Ci). We proposed the use of AGFA GEVAERT D7 Pb film. In our experience the quality of the exposure does not suffer if the dose originating from other than the instrument source does not exceed 8 percent of the dose rate specified for the film. The specified dose rate for the D7 film is $1.81 \cdot 10^{4}$ $C.kg^{-1}$ (0.7 R). Taking into consideration the irradiation doses generated by the pipe system and the environment, we calculated that the usable source activity is 1.85 TBq (50 Ci). This figure contains a large safety factor. This means that the source must be ordered for delivery at the starting time of the examination since, taking the testing time into consideration, the work can then be completed within the half life of the source.

The basic unit of the defectoscopic system is a mobile carriage, illustrated in Fig. 2. The rods of the dual-acting pneumatic working cylinders (2), mounted on the shields (1),keep the rollers (4) pressed outward. The rollers move in the carrying plates (3) in bearings. We mount the Ferodo-clad

support arcs (6) on the dual-acting pneumatic working cylinders (5). The shields are connected via the dual-acting pneumatic working cylinder with universal joints in the connection. The two shields are assembled rotated 60° with respect to each other. A shield holds three support plates and three support arcs. All pneumatic working cylinders are secured against rotation with guide rods (11).



2. ábra. Járógép: 1. Pajzs; 2. Munkahenger; 3. Hordlemez; 4. Görgő; 5. Munkahenger; 6. Támív; 7. Léptető munkahenger; 8. Vezérkábel; 9. Kardános gyorskapcsoló; 10. Csőfal; 11. Vezetőrudak

Fig. 2. Mobile unit

Key:
1 - Shield
2 - Working cylinder
3 - Support plate
4 - Roller
5 - Working cylinder
6 - Support arc
7 - Stepping working cylinder
8 - Control cable
9 - High-speed universal joint coupling
10 - Tube wall
11 - Guide rods

When moving, the working cylinders holding the support arcs contract in pairs and then the working cylinder moves the freed shield forward (or pulls it) while it rolls supported by the roller. The working cylinder (7) pulls the control cable (8) after it. The cable contains, within a glass-fiber reinforced polyethylene tube, the operating-air and electrical control lines. The control automatic system is located preferably externally, above the main circulating pump. The operating electromagnetic valves are accommodated on the carriage. The screen carriage is may be coupled to the main carriage via the high-speed universal-joint coupler. According to our calculations, the pulling force of the carriage is 1,570 N (160 kp). This is sufficient

for vertical propulsion also. The pressure of the supply air is 0.8 MPa (8 $kp \cdot cm^{-2}$). If there is a malfunction, the pressure of the supply air is dropped to zero and the carriage can be pulled out from the tube by tugging at the control cable. We made the length of the carriage such that it can be placed in the tube via the pump housing after the pump rotor has been removed. According to our model experiments, supported by kinetic calculations, this structure will move dependably inside the given pipe system.

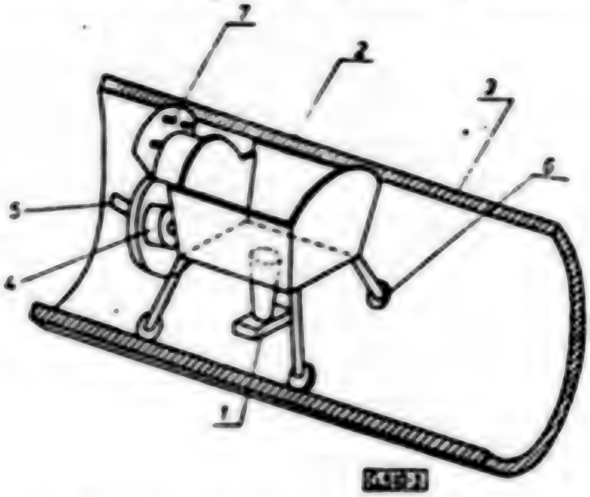


Fig. 3. Screen carriage

Key: 1 - Camera

2 - Screen, assembled from parts

3 - Tube wall

4 - Rotator

5 - High-speed universal-joint coupler

6 - Wheels

7 - Six incandescent lamps (12 V/15 W)

Figure 3 illustrates the screen carriage which was designed on the basis of the screen found best suited for the intended purpose in the experiments. We mount one photographic or television camera on two screens, each made up of parts. The baseplate of the screen is coupled to the carriage via the universal-joint high-speed coupler (5). Thus, the baseplate may tilt in respect to the carriage but cannot rotate. The pneumatic rotator mounted on the baseplate (4) can rotate the screen all around, so that the camera views the entire tube wall. Six wheels guide the screen and ensure that the distance between the camera optical system and the tube wall remains constant. The compound movement—rotation and advance—of the screen carriage ensures that the wheels rotate freely in any direction. Thus, they are

of spherical shape. The wheels are mounted on spring-loaded telescopic legs since this is the only way in which we can ensure that there is adequate support and centering.

According to our experiments, the screen is assembled from white (brightening) and black (light-absorbing) surfaces. Figure 4 illustrates the radiographic exposure head. Within the tungsten sphere (1), the pneumatic working cylinder (3) moves the torpedo (4) with the radiation source (5). During exposure the radiation source is stationed between two tungsten collimators to avoid blurring resulting from scattered radiation. The head is secured to the shield of the carriage in the place of the universal-joint high-speed coupler with the flange of the dual-walled support tube (6). The actuating air is supplied to the working cylinder (3) between the two walls of the support tube.

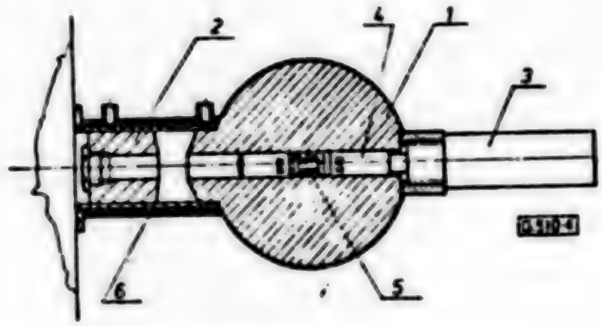


Figure 4. Radiographic exposure head

Key: 1 - Tungsten sphere
2 - Tungsten collimator
3 - Pneumatic actuating cylinder
4 - Torpedo
5 - Radiation source
6 - Support tube

The automatic system constantly monitors and displays (on the control console) the location of the carriage; it counts the steps. The length of a step is 50 mm; the tolerance—arising from the character of the actuating cylinder—is ± 0.02 mm. We install signal generators to sense the rotation of the screen carriage, and display the camera position in the control console also. In this manner the operator can always see which point of the pipe surface is in view. When recording the examination picture, it would be possible to record continuously these longitudinal and polar coordinates

so that the locational coordinates of the pipe surface on the picture can be properly assigned. This facilitates comparison with pictures taken and recorded earlier.

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2542
CSO: 2502

FINDINGS OF NONDESTRUCTIVE MATERIAL TESTS CONDUCTED AT NOVOVORONEZH

Budapest GEP in Hungarian Vol 31 No 7, Jul 79 pp 266-268

[Article by Imre Balassai, graduate chemical technologist and welding technologist, Powerplant Repair and Maintenance Enterprise, Budapest]

[Text] The author describes the methods and equipment used in radiographic, ultrasonic, leakage, dye-diffusion, and local metallographic tests at the nuclear powerplant in Novovoronezh.

According to information obtained from the Materials Testing Laboratory and the Training Center of the nuclear powerplant in Novovoronezh, the Materials Testing Laboratory must play a major role in the organizational structure of the powerplant, under the direct supervision of the director or the chief engineer.

Even before it is completed, the Materials Testing Laboratory must have the following:

a) A minimum and maximum test program (the minimum program includes those tests which must be carried out in all cases; the maximum program contains additional tests which provide additional information).
b) A test program for the period preceding the construction of the powerplant and during the construction.
c) A test program covering installation and startup of the powerplant (pressure test, 1st retest, cold- and hot-start, physical startup).
d) A program of operations for the operating period.

The following organizational structure is thought to be optimum for the Materials Testing Laboratory of the nucle.. power plant:

1. Destructive materials testing group, to carry out mechanical, metallographic, chemical, and spectroscopic tests, with 2-3 individuals per team. The teams help each other out as the need arises.
2. Nondestructive materials testing group, to carry out all nondestructive tests. Since most materials tests are nondestructive, this group has many members: 15-20. The testers working in this group may be organized into teams as the character and urgency of the tasks require.

Since the time for construction and for the 1st and 2nd retests is short, the staff has to be trebled or quadrupled for this period. The required staff will be provided by other materials testing laboratories.

3. Within the framework of the materials testing laboratory, three welding technologists will be employed for handling documentation related to welding, as well as for setting up the tests during and after welding.

In the materials testing laboratory of the nuclear powerplant, each staff member will obtain a very detailed job description which includes:

- The radiation-protection and occupational-safety regulations governing the staff member's assignment;
- The rights and obligations of the staff member (responsibilities), his organizational status, and the disciplinary rights of his supervisor;
- All information, standards, and textbooks required for carrying out the assignment;
- Detailed technical descriptions as required.

Below we discuss the nondestructive test methods, equipment, and methods of evaluation used at the Materials Testing Laboratory of the nuclear powerplant in Novovoronezh.

Inspection

The widths and heights of the welded seams are checked with the aid of steel templates.

Endoscopes are used to check the internal surfaces and roots of welded seams of chambers, drums, and pipes. The endoscopes are of Soviet manufacture. Their technical specifications: rigid endoscopes or the RVP type. The rigid tube is assembled of four parts up to a length of 6.5 m; the viewing angle is 70°; the diameters range between 12 mm and 37 mm.

The fiber-optics endoscope is of Type OD 203. The length of the fiber optics is 1.5 m; its diameter is 14 mm. Lighting uses 12 V, 200 W bulb. The fiber optics system is movable.

Radiographic Tests

The X-ray devices (operating at 200 kV) are of Soviet manufacture, using manually controlled uranium and tungsten lined isotope carriers. Data on the isotopes used in the tests:

Ir-192; active size: 4 mm x 5 mm
Cs-137; active size: 6 mm x 10 mm
Tm-170; active size: 7.5 mm x 8 mm

As a result of the large active size, relatively large film-to-focus distances must be kept. This significantly increases the exposure time.

No lead strips with numerals are used in taking the radiographs. Test exposures are used to establish the number of radiographs to be taken of pipes with diameters of up to 130 mm:

$$\frac{\text{Seam length}}{\text{Evaluatable radiograph length}} + 1.$$

The X-ray film types used are of Soviet manufacture:

Film type	Dose required for a blackening of 2S
Rt1	$2.00 \cdot 10^{-2}$ Ckg^{-1} (80 R)
Rt4	$2.07 \cdot 10^{-3}$ Ckg^{-1} (8 R)
Rt5	$7.76 \cdot 10^{-4}$ Ckg^{-1} (3 R)

The standards, of stepped and grooved design, are made of the material used in the construction of the part tested. In testing active materials, a 1-2 mm thick PVC [polyvinyl chloride] foil is placed between the film and the sample to absorb the β radiation.

The radiographs are evaluated according to PK 1514-72.

There are three groups or evaluation categories (Ball):

Ball 1 = Not usable (but repairable)
Ball 2 = Not quite satisfactory (but may be used)
Ball 3 = No fault (satisfactory)

The fault criteria listed in the tables of PK 1514-72 correspond to Ball 2.

The following notations are made in the test report:

Number of defects	Type of defect	Diameter of defect	Class of defect
3	Aa	2	Ball 2 (examples)

Meaning: Three gas bubbles, maximum diameter 2 mm, may be used.

or

Number of defects	Type of defect	Diameter of defect	Class of defect
1	Ad	2-20	Ball 1

Meaning: One gas cluster, diameter of the largest gas bubble 2 mm, diameter of the gas cluster 20 mm, not usable.

This seems to be "more descriptive" than the defect description method specified in MSZ [Hungarian Standard] 4310/5.

Table 1 shows the Soviet symbols used for welding defects.

Ultrasonic Tests

The instruments used are of Soviet manufacture; Types UDM 1, 2, 3, and 5. They operate at frequencies of 0.8 to 5 MHz. The test probes have 30, 40, 50, and 65 degrees. The test technology includes:

- The type of the instrument;
- The designation of the sample or seam examined, and its division (circular seams are divided into six parts);
- The type of the probe, its movement and calibration;
- Gain and filtration.

Separate samples are prepared for adjusting the sensitivity for each material type, probe, and wall thickness.

The UH [ultrasonic] test report records only the defects above the recording limit. The defects are designated as follows: A - point-like; B - volume-like; V - plane-like.

Description of a defect in the test report: for example 1-2 A 5-12 Ball 2 means that there are five point-like defects in Seam Section 1-2, the equivalent defect size of the largest defect is 12 sq mm (approximately 3.9 mm

diameter), may be used. The defect criteria given in the tables of PK 1514-72 correspond to Ball 2.

Leak Testing

- The compressed-air method is seldom used because of the explosion hazard.
- The ammonia test uses gaseous ammonia or an ammonium solution of 5-10%. The pressure is 1/5 of the operating pressure if gas is used and the operating pressure if solution is used. The indicator is phenolphtaleine.
- The halogen tests will be stopped because of environmental contamination considerations. At the present time, freon is used primarily for checking the measuring rods (dry channels serving for the introduction of in-zone fluxmeters) and the stationary parts of the circulating pumps. It is used for testing austenitic materials only if the freon can be completely removed after completion of the test. Two technologies are used for checking the measuring rods:

  a) The freon is introduced into the tube (at a pressure of 0.6 MPa) and sensed at the external surface. (The defect site may be localized.)
  b) Vacuum is established in the tube ($5 \cdot 10^{-2}$ torr) and the tube is surrounded by a 50%/50% mixture of freon and air at a pressure of 1 MPa. The freon is sensed in the vacuum. (The defect site cannot be localized.). The Soviet-made instrument used is Type GTI-6. Its sensitivity is $5 \cdot 10^{-5}$ lit/sec or 0.5 g/year.

- The helium method is used for checking materials of a wall thickness between 1 mm and 8 mm, flange seals, and threaded connections for leakage. (if the material thickness is more than 8 mm, no leak defect is likely; if the material thickness is 0.6 mm, helium is likely to leak because of the gap between crystals).
- The ultrasonic leak search uses the principle that the leakage flow of gas, vapor, or liquid generates ultrasound in the material. The ultrasonic probe is placed over the tube to determine the site of the leak at an accuracy of 50 cm. The method is used for testing hot, active, and inaccessible pipes and pipe bundles. The Soviet-made instruments used are Type TEA.
- The principle of the luminescence test is that sodium fluoresceinate ($C_{20}H_{10}O_5Na_2$) fluoresces under ultraviolet light. After the pressure test (if no leakage was noted) it is used first at the pressure of 1 MPa and then at the operating pressure. The detection limit of sodium fluoresceinate ("Uranyin" in vernacular) is 30 mg/liter. A solution of 50 mg Uranyin per liter water is used in the tests. The instrument for sensing is of Soviet manufacture, Type OLD-41.
  This method is used for the heat exchanger of the special water purifier and the steam generator.

Table 1. Soviet symbols for weld defect types

Defect type	Symbol Cyrillic	Symbol Latin
Gas:	п	P
Bubble-like gas	пу	Pu
Gas chain (series)	цп	Cp
Gas nest	сп	SZp
Slag:	ш	S
Bubble-like slag	шу	Su
Sharp-edged and cornered slag	ош	Os
Chain (series) slag	ч	Cs
Slag nest	сщ	SZS
Tungsten inclusion:	в	V
Bubble-like tungsten	ву	Vu
Sharp-edged and cornered tungsten	ов	Ov
Chain-like tungsten	цв	Cv
Tungsten nest	св	SZV
Joint defects:	н	N
In the root	нк	Nk
Both sides	нм	Nm
Between the beads (oblique)	нр	Nr
Cracks:	т	T
Longitudinal	тб	Tv
Transverse	тп	Tp
Multidirectional	тр	Tr
Edge burn:	пр	Przs
Root-side edge burn	пдр	Pdr
Overflow:	прп	Prp
Concave seam root	утж	UTZS

Dye-Diffusion Test

This is the most often used method. Penetrating (red) liquid types:

KD 1 Between 8°C and 40°C, minimum surface defect capable of being detected: up to 0.003 mm width and 0.02 mm depth.

KD 2 Between -40°C and +8°C, minimum surface defect capable of being detected: up to 0.005 mm width and 0.02 mm depth.

Composition of the KD 1 liquid:
300 ml gasoline, 600 ml methyl alcohol, 100 ml transformer oil, Type "Zh" dye (10 grams).

Composition of the KD 2 liquid:
470 ml gasoline, 30 ml xylene, 500 ml methyl alcohol, Type "Zh" dye (5 ml), Type "5 S" dye (5 ml).
Composition of the developer (white) liquid:
500 ml ethyl alcohol, 500 ml water, 400 grams kaolin.

The kerosene test is still used in sites of lesser importance.

Local Metallography, Replica Preparation

The local metallographic examination is carried out with a Type MPB-2 magnifier on a surface prepared to a fineness of 14.
The magnifier is a version of the lens system used in the Poldi test for a magnification of 100X.

The methods used for local electrolytic polishing and etching:
- Surface pretreatment to Degree 7 with conventional methods, followed by electrochemical polishing and etching. The electrolytic polisher is Type UEP-2M, a Soviet-made instrument with silicon rectifier.

Electrolyte for the Polishing of Austenitic Steels:
100 ml CH_3COOH (acetic acid); 50 ml $HClO_4$ (perchloric acid). Voltage: 26 V; current: 0.15-0.5 A; polishing time: 1 min. The same electrolyte is used for carbon steels; the voltage is 40 V and the polishing time is 1.5 minutes.

Electrolyte for Etching Austenitic Steels
1. 20 g $C_2H_2O_4.2H_2O$ (oxalic acid), approx. 8 ml HNO_3, 220 ml H_2O; voltage: 6 V, current: 0.5 A, etching time: 2-3 minutes.
2. 10 g $C_2H_2O_4.2H_2O$ (oxalic acid), 90 ml H_2O; current: 0.15-0.2 A, etching time: 70 seconds.

A replica is prepared of the polished and etched surface.
Method: Polystyrene cube, polished with Polishing Paper M 40; the paper bears against the tube, so that the cube assumes the shape of the tube. The polished surface is immersed in benzene or dichooroethane, and pressed against the etched surface for up to three seconds. The solidification time depends on the temperature of the metal (for example four hours at over 20°C).
A polishing is made at least on three location of the material being tested, and 2-3 replicas are made of each location.

2542
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TESTS FOR SURFACE CLEANLINESS OF AUSTENITIC STEELS IN NUCLEAR POWER PLANTS

Budapest GEP in Hungarian Vol 31 No 7, Jul 79 pp 271-273

[Article by Jozsef Ujhelyi, graduate chemical engineer, corrosion-engineering specialist, Research Institute for the Ferrous Metallurgical Industry, Budapest]

[Text] 1. Introduction

Strict standards apply for the surface cleanliness of structural parts made of stainless steel in nuclear power plants for various reasons:

a) If stainless steel is corroded, the product of the corrosion—of which the quantity is also determined by the surface treatment—becomes activated and causes significant background radiation in the primary loop of the power plant during operation.
b) Impurities left on the surface of steel structural parts after finishing may contribute to the corrosion of the steel and, after activation, to increased background radiation.
c) Corrosion products from the surface of water-processing and -storing equipment may enter the secondary or even the primary loop with the secondary water, where they accumulate.

Various chemical surface treatment methods must be employed for the cleaning of the surfaces of rolled metallurgical products as well as cold- and hot-formed and heat-treated (or untreated) parts used in the manufacture of nuclear power plants made of stainless steel.

In evaluating the surface changes, condition, cleanliness, and surface quality of mechanically formed and chemically treated stainless-steel products we considered factors capable of affecting corrosion resistance.

2. Factors Affecting the Corrosion-Sensitivity of Acid-Resistant Steels

The past history (manufacture, fabrication, trsnsportation, and so forth) of an austenitic acid-resistant steel affects the steel's corrosion-sensitivity.

In the manufacture of the acid-resistant steel 08X18H10T, the procedures are similar to those used for other steel products, namely production of ingot and 5-30 mm thick sheet by rolling, in one or several step(s). The rolling is followed by heat treatment (400-800°C), pickling with sulfuric acid, annealing, and cutting to size. Intercrystalline corrosion may take place in the course of the heat-treatment. The risk of intercrystalline corrosion may be reduced in VVER-440 type pressurized-water nuclear power plants by using titanium-stabilized austenitic chromium-nickel steels.

At the temperatures employed in the stress-relieving heat treatment of carbon steels (620-650°C), austenitic chromium-nickel steel becomes sensitized if in contact; in the case of titanium-stabilized 18/10 chromium-nickel steel, the weld seams may also become sensitized [1].

Alloying with titanium reduces the precipitation of chromium carbides having the formula $M_{23}C_6$ from stabilized austenitic steels; this also reduces the chromium depletion near the crystal boundaries.

3. Microgeometric Study of Mechanically Formed and Chemically Treated Steel Surfaces

The formed and chemically treated steel surfaces have a secondary roughness profile after each process. The primary profile is the profile before the processes. In was our experience that if the primary profile is negligibly rough, the secondary profile depends primarily on the technological parameters of the treatment process(es). If, on the other hand, the surface had a determinable roughness profile before the treatment, the primary profile also affected the secondary profile. The goal of our studies was, on the one hand, to select the parameters of importance in connection with corrosion resistance from among the microgeometric parameters.

Table 1 summarizes the microgeometric parameters of some types of stainless steel after various kinds of surface treatment. We express our thanks to the Department of Machine Components of Budapest Technical University for valuable help in the microgeometric measurements.

Conclusions: Insofar as general corrosion resistance is concerned, an important factor is the depth of the roughness of the final profile R_{max}, as well as "r" (the rounding radius of the roughness peaks, which is especially undesirable if small). Another factor of importance is the configuration of the surface roughness, meaning the ratio of maximum roughness depth (peak or valley) and roughness width. The greater is the roughness width, the more tub-like is the profile section and the less dangerous is the maximum roughness depth. The smaller is the roughness width, the more zig-zaggy is the profile section and the more dangerous is the maximum roughness depth. This is indicated by the ratio of the profile completeness (degree of filling), which is expressed by the carrier length (tp).

4. Studies of the Surface State of Stainless Steels and Conclusions

We carried out scanning electron-microscopic studies on hot-formed, heat-treated, non-heat-treated, and rolled metallurgical products.

In formed test specimens the surface layers crack if forming to cause major change is employed. As a result, oxides with undesirable composition and morphology develop on parts of the surface of the highly deformed surface. These oxides do not dissolve fast enough, so that chemical treatment for cleaning cannot be accomplished without damage to other parts of the surface. We prepared scanning electron micrographs of the surface of hot-formed, heat-treated specimens after chemical treatment. Figure 1 illustrates the electron micrograph. Porous contaminants remaining on the left side of the surface may facilitate the adsorption of contaminants and ions. On the right, we can see a pure metal portion, with a spherical contamination "sitting" on it (containing elements of low atomic number).

We can see a uniformly etched pure metal surface covered with a passive protection layer in micrographs taken from degreased and properly formed and shaped specimen surface, and also by macroscopical observation (Fig. 2).

We carried out corrosion tests on sheet samples after hot-forming, cold-forming, and rolling after various kinds of chemical surface treatment. By means of the Huey test we were able to measure the corrosion rate under the simultaneous influence of several factors. The corrosion resistance of the base material becomes increasingly predominant as the test time goes on, while the effect of the surface layer becomes less significa[illegible] 4).

Cold forming does not sensitize the austenitic steel 08X18H10T against intercrystalline corrosion.

Table 1. Microgrometric parameters of the surface of stainless steel types

Designation	R_a m	R_{max} m	r m	r' m	r/R_{max}	tp %	Roughness class
Hot-formed, heat-treated	5-16	42-160	9-330	9-110	0.14-2.06	-	3
Hot-formed, heat-treated, pickled	10-180	10-150	4-118	4-125	0.04-0.94	-	3
Cold-formed, heat-treated	5.54-7.5	30-78	5-703	5-703	0.1-17.1	35	
						58	4
						80	
Cold-formed, heat-treated, pickled	6.7-8.3	48-82	4-167	4-128	0.06-2.7	24.5	
						38	4
						61	
Rolled sheet	2.2-5.4	17-67	7-732	10-478	0.1-18.0	23	
						52	6
						83	
Rolled sheet, pickled	1.5-2.0	12-18	10-295	13-478	0.9-20	34	
						62	6
						87	

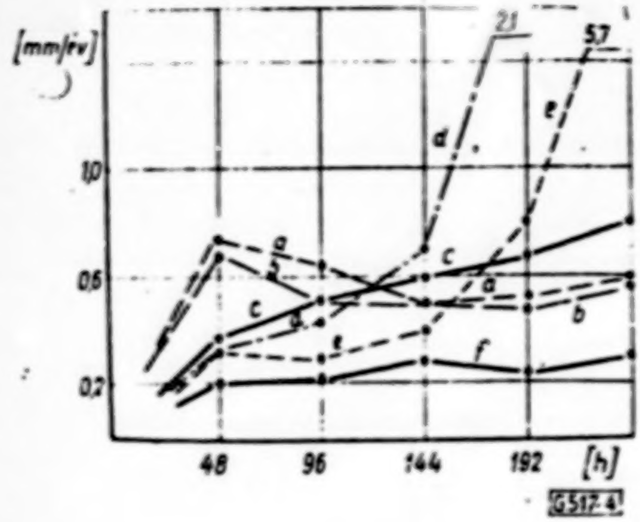

Fig. 4. Corrosion test with the Huey method. a) Cold-formed; b) Cold-formed, paste-cleaned; c) Rolled sheet; d) Hot-formed, heat-treated, pickled; e) Hot-formed, paste-cleaned; f) Cold-formed, heat-treated, pickled.

Samples hot-formed with the current manufacturing parameters became sensitive to intercrystalline corrosion. The roughness of the surfaces slightly deteriorates during chemical cleaning, but usually does not exceed the value of 40 µm.

We also evaluated the surface cleanliness of various semifinished products, sheet, and cold- and hot-formed products after acid and paste surface treatment, using the Schwenk test.

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2542
CSO: 2502

BRIEFS

COMPUTER OPERATING COSTS, REQUIREMENTS--The average cost per hour of computer operation in Poland is 3,000 zlotys. In contrast to the current 10-year period, the expansion of automation in Poland in the period 1980-90 and thereby the expansion of production of computers and computer systems for automation and measurements will be determined by two factors: necessity for an annual production increase of 6 to 8 percent in industry; and reduction of direct labor in production as a result of a drastic reduction in the labor-force input in the period 1980-90 in comparison with the period 1970-80. In this connection, it will be impossible, in the period 1980-90, to install non-automated machines, because it is impossible to increase production by increasing the number of even technologically modern machines and by the very increase of employment. Each machine and production flowline installed after 1980 must be equipped, to a lesser or greater extent, with automated systems--from the most simplified to the most complicated systems. [Excerpts] [Warsaw FUNDAMENTY in Polish 9 Sep 79 p 4]

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